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SPANISH RINGING AND RECOVERY RECORDS OF BOOTED EAGLE (*HIERAAETUS PENNATUS*)

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KEY WORDS: *Booted Eagle*; Hieraaetus pennatus; *mortality*; *longevity*; *philopatry*.

Scientific ringing is a useful method to study many aspects of the life history of birds, and is especially important for the study of migration. Information about migratory routes and wintering areas of raptors is necessary for understanding the factors affecting the conservation of these species outside the breeding areas, such as habitat loss, environmental contamination, or human interference (Zalles and Bildstein 2000). This is particularly relevant for raptor species that perform long migratory journeys, which may be especially vulnerable to human impacts. Furthermore, the concentration of a large number of individuals during migration increases the potential for natural and antropogenic impacts such as shooting and trapping (Zalles and Bildstein 2000).

The Booted Eagle (*Hieraaetus pennatus*) breeds in southern Europe and winters in Africa (Cramp and Simmons 1980). In winter, Booted Eagles breeding in Europe may move southward into the area where Booted Eagles nest in southern Africa (Brooke et al. 1980, Pepler et al. 2001, D. Pepler and R. Martin unpubl. data). There are some data on the numbers of Booted Eagles crossing the Gibraltar Strait (Bernis 1973, Garzón 1977, Cramp and Simmons 1980, Finlayson 1992, Zalles and Bildstein 2000), the Messina Strait (Thiollay 1989, Zalles and Bildstein 2000), the western Pyrenees (Iribarren 1973, Zalles and Bildstein 2000), the Bab-el-Mandeb Strait (Welch and Welch 1989, Zalles and Bildstein 2000), and other localities during post-nuptial migration to Africa (Zalles and Bildstein 2000). However, little is known for this species about the routes used during migration to Africa, wintering areas, use of stop-over sites during migration, habitat use in wintering areas, threats outside the breeding season, where first-yr birds spend their second summer, and philopatry. This paper presents a first analysis of ringing and recovery records of this species in Spain for mortality rates, migratory routes, dispersal movements, and longevity in the Booted Eagles.

METHODS

Ringing data presented in this paper were obtained from the Ringing Office of the Spanish General Direction of Nature Conservation. These include only recoveries of Booted Eagles ringed in Spain. From 1973–99, 2080 Booted Eagles were marked with metal rings in Spain (Hernández-Carrasquilla and Gómez-Manzanaque 2000), of which 80 have been recovered (as of 2001). For this analysis, the recovery records have been divided into four periods: (1) breeding, 15 March–14 September; (2) post-nuptial migration, 15 September–14 November (15 d before of the peak passage through the Gibraltar Strait until the beginning of the wintering period; Bernis 1973); (3) winter, 15 November–14 February (Bernis 1980); and (4) pre-nuptial migration, 15 February–14 March (only one case that has not been included in the analyses). Eagles were classified into one of three age classes: juveniles (<1 yr), immature (2–3 yr), and adults (>3 yr; Newton 1979, Cramp and Simmons 1980).

RESULTS AND DISCUSSION

Causes of Recovery. From 80 Booted Eagles ringed in Spain and subsequently recovered, 58.8% were found dead, 18.8% were found alive and immediately released, and 13.8% were found alive but were not released due to their poor physical condition. No detailed information could be obtained for the remaining 8.8% of ringed ea-

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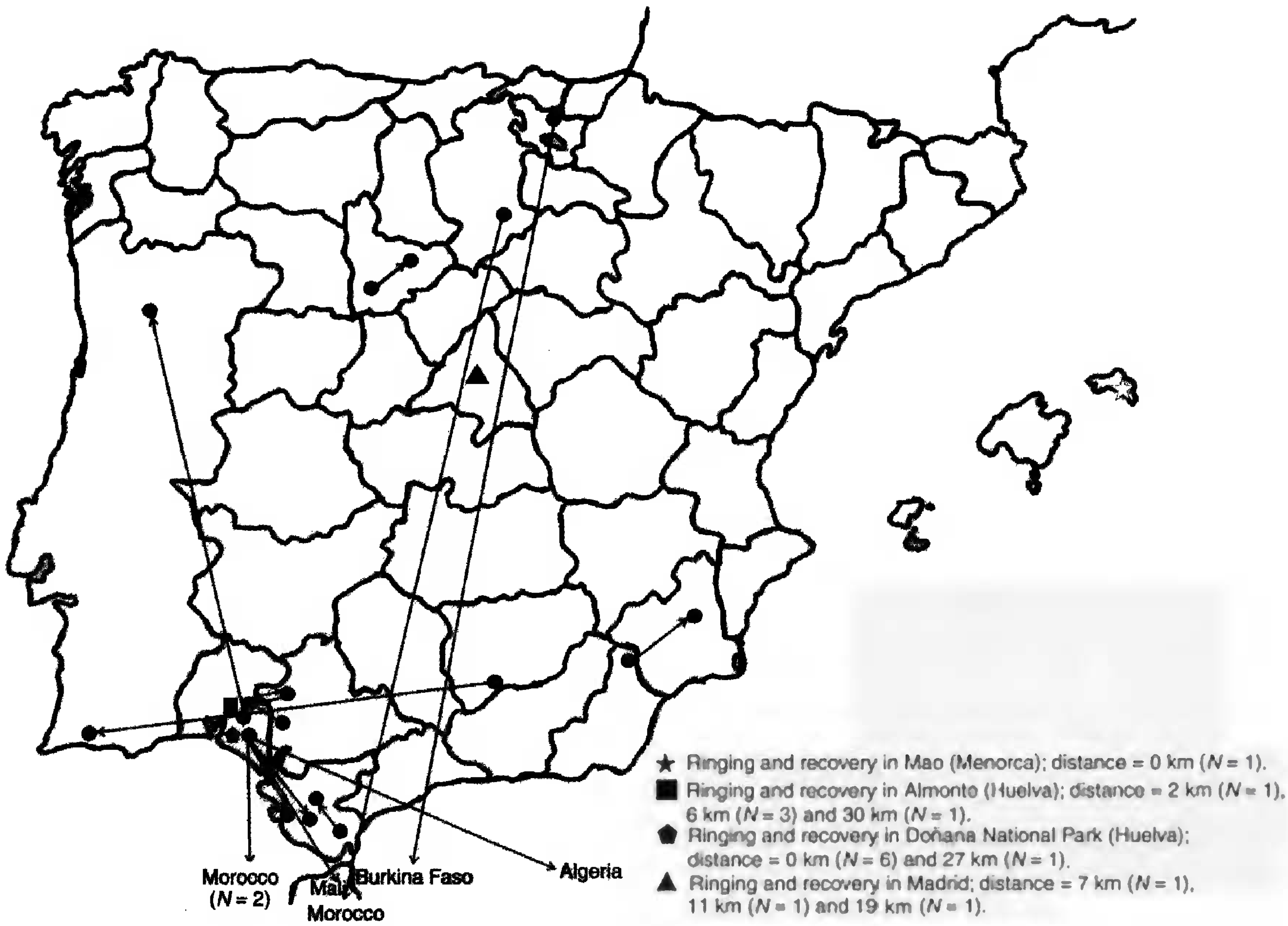

Figure 1. Ringing and recovery localities during breeding period (15 March–14 September) of Booted Eagles marked in Spain. Recoveries of birds that were ringed during the same breeding season were excluded.

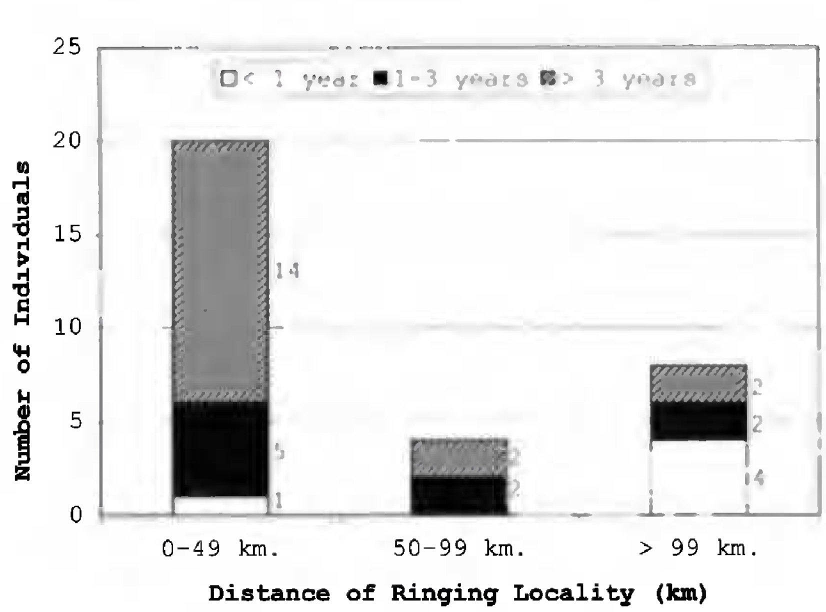

Figure 2. Distribution of dispersal distances of Booted Eagles from their natal place during breeding season, excluding data of birds ringed and recovered during the same breeding season.

gles. The percentage of birds found dead was greater for juveniles and immatures (combined; 72%, $N = 50$) than for adults (36.7%, $N = 30$). This difference was statistically significant (Yate's corrected $\chi^2 = 8.26$, $P = 0.01$). This is consistent with the pattern that young raptors tend to have higher mortality rates than adults (Newton 1979).

Causes of mortality were: shooting (21.3%), drowning (14.9%), collision with electric powerlines or electrocution (8.5%), trapping (6.4%), general trauma (6.4%), poison (4.3%), predation by other raptors (2.1%), predation by other wild animals (2.1%), collision with cars (2.1%), and unknown (31.9%).

Causes of mortality in juveniles were largely related to human activities (drowning 29.2% and shooting 20.8%). The inexperience of juveniles may explain the high number of individuals found drowned (Newton 1979), as this cause of mortality was never recorded for adult birds. The primary cause of mortality for adults was shooting (27.3%), which was also common for juveniles (20.8%) and among immatures (20.0%). Thus, illegal killing seems to be a significant mortality factor for this species,

Figure 3. Ringing and recovery localities (filled circles) during autumn migration (15 September–14 November) of Booted Eagles marked in Spain. Recoveries within Balearic Islands, where the species is sedentary, have been excluded.

including within Spain, where illegal predator control is still an important conservation problem (Villafuerte et al. 1998).

With respect to those birds found alive and immediately released, the circumstances of the recovery were trapping (40.9%), found inside buildings (13.6%), found with general trauma (9.1%), or found chilled (4.5%). Among the birds found alive, but not immediately released, 36.4% had general trauma, 27.3% were exhausted, 9.1% had been shot, 9.1% had collided with electric powerlines, and the causes were unknown for the remaining 18.1%. There were seven records with no information about the recovery.

Dispersal Distances. The longest distances between ringing and recovery locations for Booted Eagles marked in Spain were recorded for birds wintering or migrating in sub-Saharan African countries. The greatest distance record was for an eagle ringed in Alava (northern Spain) and recovered after 1093 d in Burkina Faso (3530 km). Three other records corresponding to long migration journeys were of nestlings ringed in Murcia (southeastern Spain) and Doñana National Park (province of Huelva). The first was trapped after 184 d in Nigeria (3110 km). The second was found predated by a raptor 503 d later in Togo (2980 km). The third was found dead 546 d later in Mali (2708 km).

Philopatry. To study dispersal distances after the first wintering season, I selected the recovery records made during the breeding season, excluding the records of birds ringed and recovered during the same breeding season. Of the 32 selected records, 24 (75.0%) were made at a distance less than 100 km from the birthplace (Fig. 1). Seven of these records were made at the same locality where the birds were ringed (six adults and one bird younger than one yr). Raptors tend to be philopatric, whereby young birds tend to return to natal areas when they reach breeding age (e.g., Newton 1979, Newton et al. 1994, Forero et al. 2002), and my results support this for Booted Eagles. With respect to young and immature individuals, 57.1% were recovered between 0–100 km of their birthplace. This suggests that even young, nonbreeding birds may return to their natal areas during the next breeding season. However, there are seven cases of Booted Eagles younger than 1 (N = 5) and

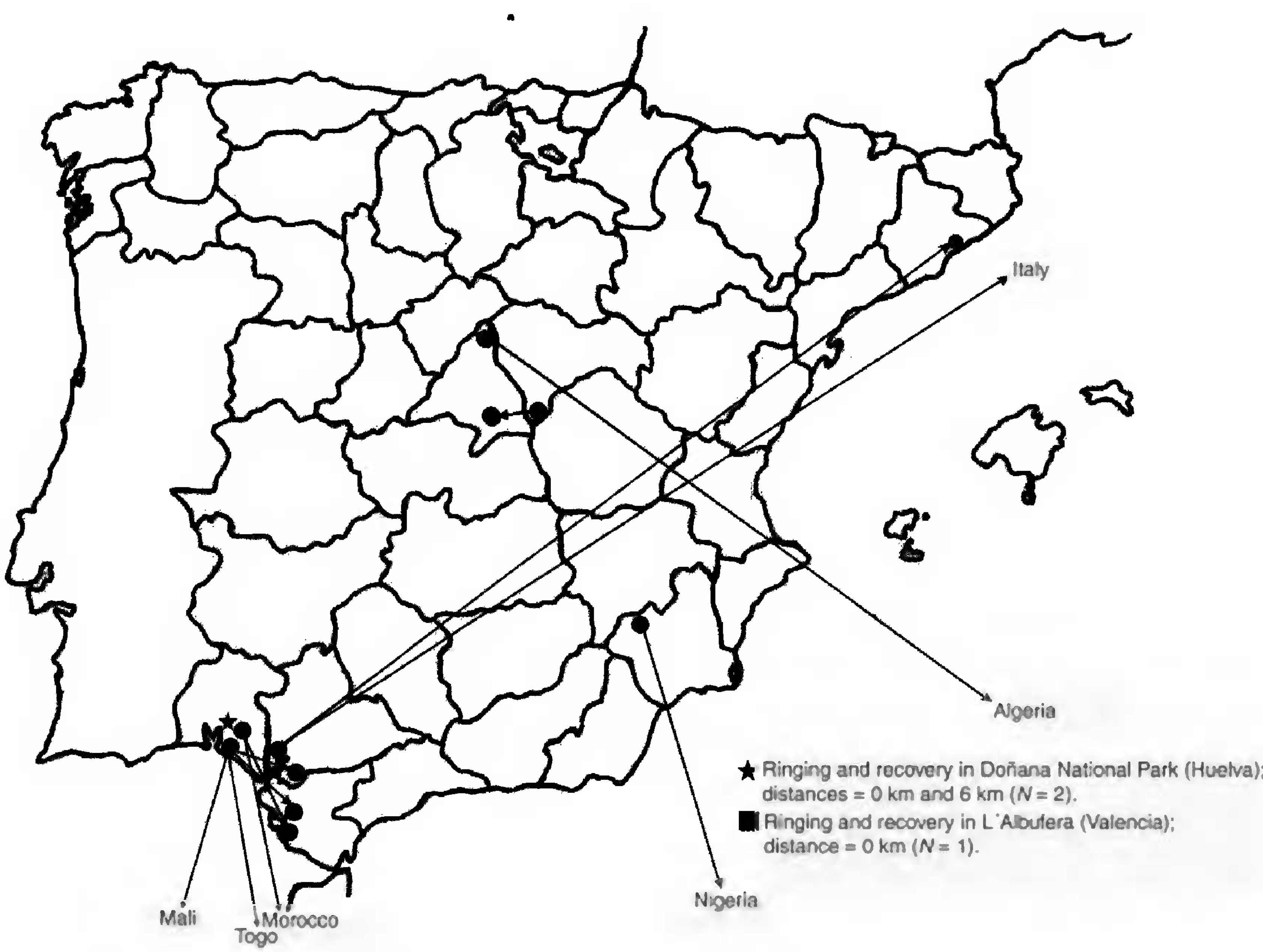

Figure 4. Ringing and recovery localities during winter (15 November–14 February) of Booted Eagles marked in Spain. Recoveries within Balearic Islands, where the species is sedentary, have been excluded.

2-yr old ($N = 2$) recovered very far from their birthplace during the following breeding season (locations of recoveries were Algeria, Burkina Faso, Mali, and Morocco). The recovery distances were significantly different among age classes (ANOVA with log-transformed dispersal distances; $F_{2,29} = 3.9$, $P = 0.035$; Fig. 2), and this suggests that probably young eagles tend to disperse further from their natal area than immatures or adult birds during breeding season. In other raptors, the proportion of individuals found near their natal areas increase with age, and young disperse greater distances in the breeding season (Newton 1979).

Longevity. The longevity record in the wild was a bird ringed as a nestling in the province of Madrid (central Spain) and recovered dead in a nearby area almost 14-yr later (5084 d-old). A 4638 d-old Booted Eagle ringed in the province of Huelva was also recovered in the Khenifra (Morocco).

Migration Direction. By using only Booted Eagles ringed and recovered in the same season (the records of the sedentary population in Balearic Islands have been excluded), I obtained a picture of the migration routes for the Spanish population (Fig. 3). The records available showed one movement east-northeast of ringing areas (Cáceres), two south-southeast of ringing areas (Cádiz), and one recovered south-southwest of the ringing area (Murcia). Recovery made at east-northeast could be due to a pre-migratory movement of bird looking for a more productive site during summer months, or perhaps represented a bird exploring possible future breeding areas (Newton 1979, Olea 2001).

Wintering Areas. Booted Eagles recovered between 15 November and 14 February should reflect wintering areas used by the Spanish population (Fig. 4). I selected 14 records, which can be divided into five groups: two eagles recovered east-northeast of ringing areas (Barcelona, Spain; Firenze, Italy), five individuals recovered in Africa during winter (Morocco, Togo, Mali, Algeria, and Nigeria; Fig. 5), one sedentary individual (Valencia, Spain), five birds wintering in southern Spain (Cádiz, Huelva, Sevilla), and one bird wintering in central Spain (Madrid).

Figure 5. Recovery locations of Booted Eagles during breeding and winter periods in Africa.

Winter recoveries at east-northeast breeding areas were surprising, because Booted Eagles generally are known to fly south from Europe to Africa (Brown and Amadon 1968, Cramp and Simmons 1980) similar to other European migratory raptors (González and Merino 1990, González 1991, Donázar 1993, Triay unpubl. data). These two winter localities for Booted Eagles, Barcelona and Firenze, are on the Mediterranean coast, where the mild winters could support a high density of passerines and a relatively high winter activity of reptiles. Passerines and reptiles are among the main prey of breeding Booted Eagles in Spain (I. García Dios unpubl. data). Sunyer and Viñuela (1996) and Martínez and Sánchez-Zapata (1999) previously suggested that several raptor species are more frequently wintering in Mediterranean areas over the last 20 yr, instead of migrating to Africa. These two Booted Eagle records are consistent with this suggestion. Despite the lower winter recovery of Spanish Booted Eagles in Africa than in Europe, the primary winter quarters for the species is Africa (Brown and Amadon 1968, Cramp and Simmons 1980). This is clearly supported by the large numbers of birds crossing the Strait of Gibraltar (Bernis 1973). The higher recovery frequency in Europe in this analysis was likely due to higher reporting rates in Europe, and not because more eagles were wintering in Europe.

RESUMEN.—En este artículo presentamos una aproximación sobre la mortalidad, migración, dispersión, y longevidad del aguililla calzada (*Hieraaetus pennatus*) basándonos en las recuperaciones de individuos de esta especie marcados con anillas metálicas. Los resultados sugieren que los jóvenes tienen una tasa de mortalidad relativamente alta, en especial debido a su inexperiencia, y que el tiroteo ilegal sigue siendo una causa de mortalidad importante. Los jóvenes tienden a dispersarse mayores distancias que los individuos adultos, aunque en general se observa una clara tendencia filopátrica. Se registran movimientos premigratorios e invernada en latitudes más norteñas que las de reproducción, lo que puede estar relacionado con una tendencia creciente a la sedentarización en el Mediterráneo. La máxima longevidad registrada por este método es de 14 años.

[Traducción del autor]

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DIET SHIFT OF BARN OWLS (*TYTO ALBA*) AFTER NATURAL FIRES IN PATAGONIA, ARGENTINA

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KEY WORDS: *Barn Owl*; Tyto alba; *fire perturbations*; *dietary shift*; *Patagonia.*

The Barn Owl (*Tyto alba*) is broadly distributed in Argentina and is found in several types of habitats such as woodlands, grasslands, and semideserts (Canevari et al. 1991). Barn Owls feed primarily on small mammals, although prey species differ slightly among different localities even in the same geographic region (e.g., in Patagonia see Travaini et al. 1997, Pillado and Trejo 2000), which implies that owls show considerable plasticity and are opportunist predators, capturing the most abundant or vulnerable prey.

In this study we describe the diet composition of Barn Owls in a locality where the type of vegetation (and the associated small fauna) changed drastically after successive natural fires in the area. Our objective is to record any change in prey use before and after the fires to assess the impact of this disturbance on the owls' feeding behavior.

METHODS

The study site was located in northwestern Patagonia (41°03′S, 70°59′–71°00′W, 900 m above sea level). The area is a transition between the arid Patagonian steppe to the east and the humid *Nothofagus* forests to the west. The area is mountainous with rocky outcrops (with caves used by owls for roosting), and the vegetation is dominated by bunchgrasses (*Stipa speciosa*), cushion bushes (*Mulinum spinossum*), and scattered bushes (*Fabiana imbricata, Discaria articulata, Maytenus chubutensis,* and *Berberis buxifolia*). At times, low trees (*D. chacaye*) form small-gallery forests. Mean annual temperature is 8°C, and mean annual rainfall is 800 mm (Paruelo et al. 1998).

Diet of Barn Owls was studied from autumn–spring 1998 by analyzing pellets collected seasonally under two roosts (likely including 1–2 owl home ranges). We divided the yr into seasons: summer (December–February), autumn (March–May), winter (June–August), and spring (September–November). In the Austral summer 1998–1999, the area was affected by successive natural fires that destroyed most of the vegetation and left large patches of bare soil. The owls abandoned the known roosting sites, but did not leave the area. We continued collecting pellets in the summer and autumn 2000, after finding new roosts in an unburned area adjacent to the burned patches and not far from the abandoned roosting sites (ca. 300 m).

Pellets were air dried and dissected using standard techniques (Marti 1987). Prey remains in pellets were identified using keys (Pearson 1995) and by comparison with reference collections. Mammalian prey were classified to species and quantified by counting skulls and mandible pairs. Birds were identified to family level and quantified by counting skulls, while insects were classified to order and quantified by counting head capsules and mandibles.

Biomass of each prey category in the total biomass of the diet was calculated by multiplying mean body mass of individuals by the number of individuals in pellets and expressed as a percent of total prey biomass consumed.

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